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Extended axion electrodynamics: Anomalous dynamo-optical response induced by gravitational pp-waves

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Abstract

We extend the Einstein-Maxwell-axion theory, including into the Lagrangian cross-terms of dynamo-optical type, which are quadratic in the Maxwell tensor, linear in the covariant derivative of the macroscopic velocity four-vector Ui, and linear in the pseudoscalar (axion) field φ{symbol} or its gradient fourvector. We classify the new terms with respect to irreducible elements of the covariant derivative of Ui of the electromagnetically active medium: the expansion scalar, acceleration four-vector, shear and vorticity tensors. Master equations of the extended axion electrodynamics are used for the description of the response of an axionically active electrodynamic system, induced by a pp-wave gravitational background. We show that this response has a critical nature, i.e., the electric and magnetic fields, dynamo-optically coupled to the axions, anomalously grow under the influence of the external pp-wave gravitational field.

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